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# MBR pilot plants operational problems during start up

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In the wastewater treatment field, research at pilot scale has become a crucial step for the decision-making process and for the parameters selection previously to the design of an industrial WWTP. Design, construction, starting up and operation of a prototype is carried out but problems in a pilot scale plant differs from those occurred in a full scale plant. The success of the research project and the WWTP performance strongly depends on this stage and issues such as a suitable selection of the instruments or the type of pumps, blowers or even valves are basic for the correct operation of the pilot plants, avoiding problems that could arise during the exploitation and maintenance of these plants.

This work analyzes the start up stage over three different MBR pilot plants built to be used for different research purposes. The plants have been designed according to different configurations and for different wastewater flowrates (from 1 to 5 $m^3$/h, from 0.2 to 1 $m^3$/h and from 10 to 50 L/h, respectively), depending on the purpose of each one. Two of these plants use ultrafiltration hollow fiber membranes and the other one uses microfiltration flat sheet membranes. The main operational problems that have occurred in each pilot plant are described in this work based on their influence over the research performance, including design advices related to the electric and electromechanical equipment and to the instruments, hydraulic calculations required for the project, construction materials selection and data storage and control.

Different types of volumetric pumps (peristaltic and eccentric helical screw) and centrifugal pumps for draining the tanks and for waste disposal have been selected. Flow rates higher than 0.2 $m^3$/h have been successfully controlled by the pumps by means of positive displacement eccentric helical screw volumetric pumps. For lower flow rates, dynamic pumps are not suitable; the high solid concentrations force to select peristaltic pumps. In the pumps market, different types of shutters can be found but they are not able to avoid biomass losses, so that for the pumps located in the recirculation loops metal shutters are used to avoid undesirable biomass losses that could make difficult to control operational parameters such as the sludge retention time (SRT) or the F/M ratio.

When a pilot plant is built for research purposes, analytical experiments in the laboratory are a fundamental part of the research, so, special attention must be paid to the samples collection system. These three pilot plants are fed continuously on raw urban wastewater whose organic load and contamination characteristics fluctuate significantly with time, punctual samples do not properly characterize the wastewater. Automatic samplers have not been used but a new sampling system has been designed to get integrated samples more representatives of the influent and effluent characteristics. This system consists on an electrovalve connected to the influent impelling pipe, this electrovalve is electrically fed by a programmer which allows taking small amounts of sample many times per day, keeping a constant flow rate inside the sampling pipeline and avoiding the influence of any other factors. Also for the effluents, integrated samples are taken connecting a 6 mm pipe to the outflow pipeline and placing an adjustable dropper at the end of this pipe to collect the sample during 24 hours. This type of sampling systems are suitable for installing on-line analyzers.



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This kind of research projects needs an exhaustive and continuous control of the whole installation. Problems such as an electric or electromechanic failure, pipeline or equipment obstruction problems, lack of influent flow rate and many other things may cause the waste of days, weeks or even months of experimental work or even important breakdowns that may strongly modify the global budget of the installation, influencing the success of the whole research project. One of the most feasible ways to avoid these problems is the use of supervisory control and data acquisition (SCADA) systems. These systems have been adapted specifically to each designed plant to get a global control of every parameter influencing the installation. For this purpose, it is necessary to make a report which includes all the operations, specifying every case study that may occur during the lifetime of the installation and the answer that must be given to each situation.

Flow rates may be controlled according to a fixed inflow rate or a fixed outflow rate, establishing the flow rates graphs, fixing a flow rate for every hour of a day, etc. To get that pumps and blowers are adjusted to the set point values, closed-loop control is needed based on the values given by the measurement instruments. Equipment performance is adjusted by means of proportional-integral-derivative (PID) controllers. A permanent control of each pilot plant is needed 24 hours a day, so that a remote control system has also been installed.

Related to the measurements of temperature and pH and control of the dissolved oxygen (DO) concentration, direct placing of these sensors inside the tanks may cause measurement uncertainties. To ensure a correct operation of the sensors, biomass must be homogeneous, so that if there is no enough mixing inside the tank due to the aeration, it would be necessary to introduce an alternative extra mixing system. Otherwise, air bubbles formed around the DO sensor must be avoided because the value given by the sensor may be erroneous. To solve these problems, sensors have been located along a specific pipeline where the mixed liquor from the aerobic tank flows continuously due to a centrifugal recirculation pump which keeps a constant flow speed in a range from 0.5 to 1.0 m/s. In case the DO concentration that must be kept inside the tank is too low, apart from the electrical devices such as frequency controllers which allow the regulation of the blowers, pneumatic or electric actuated valves are needed to increase or decrease progressively the air flow rate which enters the system.

Other operational problems such as foaming, hydraulic load losses, air carried through the pipelines which causes flow rates measurement uncertainties, etc. are also described in this work and the solutions taken to solve the problems occurred during the start up period of these three MBR pilot plants are also included.

Keywords: MBR, pilot plant, start up, operational problems